```
clear variables
```

### 3.1.1. Discretize the controller ()=/ using tustin(bilinear) transformation.

```
T = 0.05; %sampling period
k = 1;
Hc = tf(k, [1 0]);
Hc_discrete = c2d(Hc, T, 'tustin')
```

```
Hc_discrete =

  0.025 z + 0.025
  ---------------
       z - 1

Sample time: 0.05 seconds
Discrete-time transfer function.
```

### 3.1.2. Discretize the process H_p(s) = 2400 / ((s + 20) * (s + 40)) using zero order hold method.

```
Hp = tf(2400, [1 60 800]);
Hp_discrete = c2d(Hp, T, 'zoh')
```

```
Hp_discrete =

      1.199 z + 0.441
  ------------------------
  z^2 - 0.5032 z + 0.04979

Sample time: 0.05 seconds
Discrete-time transfer function.
```

### 3.1.3. Use the zpk function to write on your notebook the open loop transfer function.

```
H_ol = zpk(Hc_discrete * Hp_discrete)
```

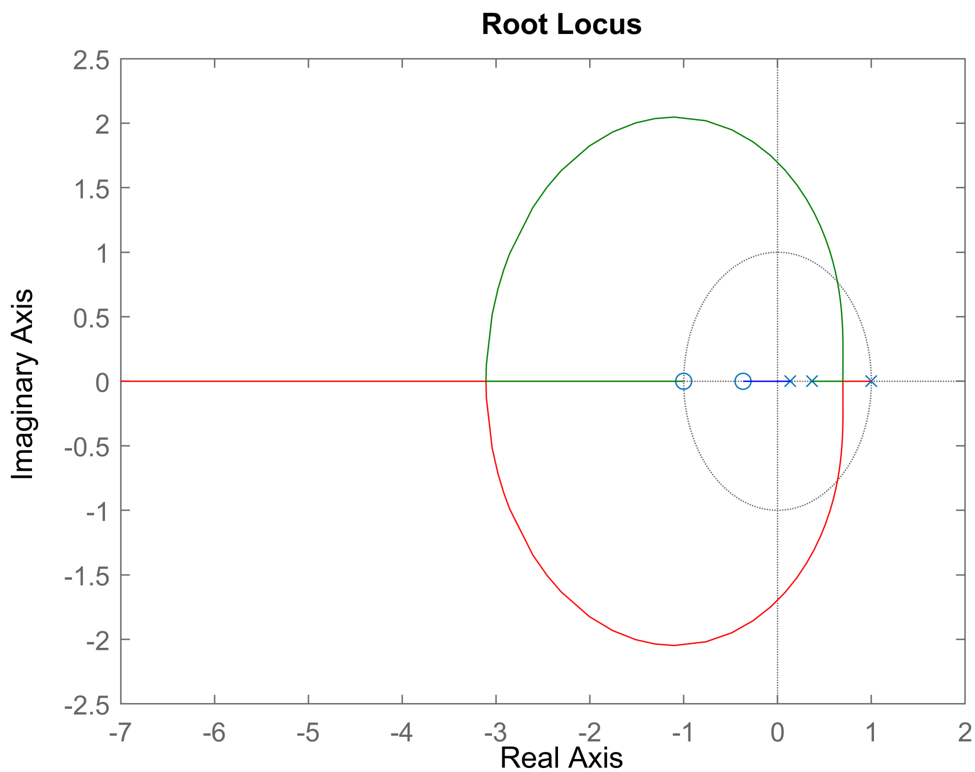
```
H_ol =

   0.029968 (z+1) (z+0.3679)
  ---------------------------
  (z-1) (z-0.3679) (z-0.1353)

Sample time: 0.05 seconds
Discrete-time zero/pole/gain model.
```

### 3.1.4. Analyze the stability of the closed loop system depending on ∈ (0, ∞); draw on your notebook the root locus and mention the obtained values of k directly on the graphics.

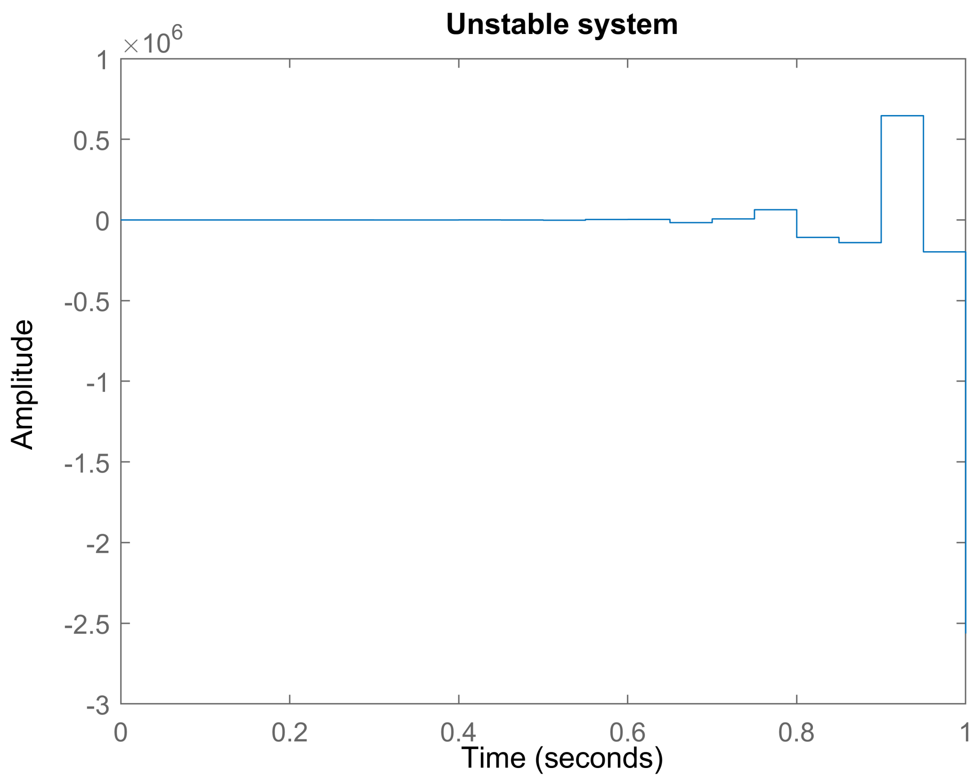
```
figure,
rlocus(H_ol)
```



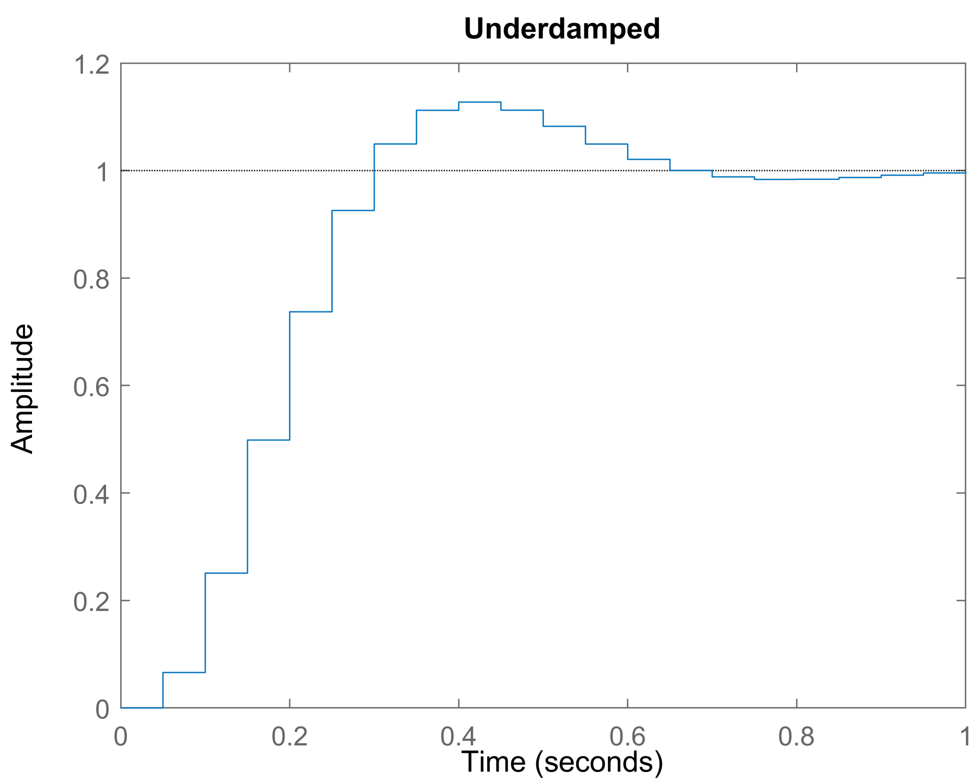

```
% k = 9.26 -> zeta = 0
```

### 3.1.5. Analyze closed loop behavior depending on ∈(0,∞); use Matlab to generate the closed loop step response for all different behaviors that result depending on k; give suggestive titles to the generated plots.

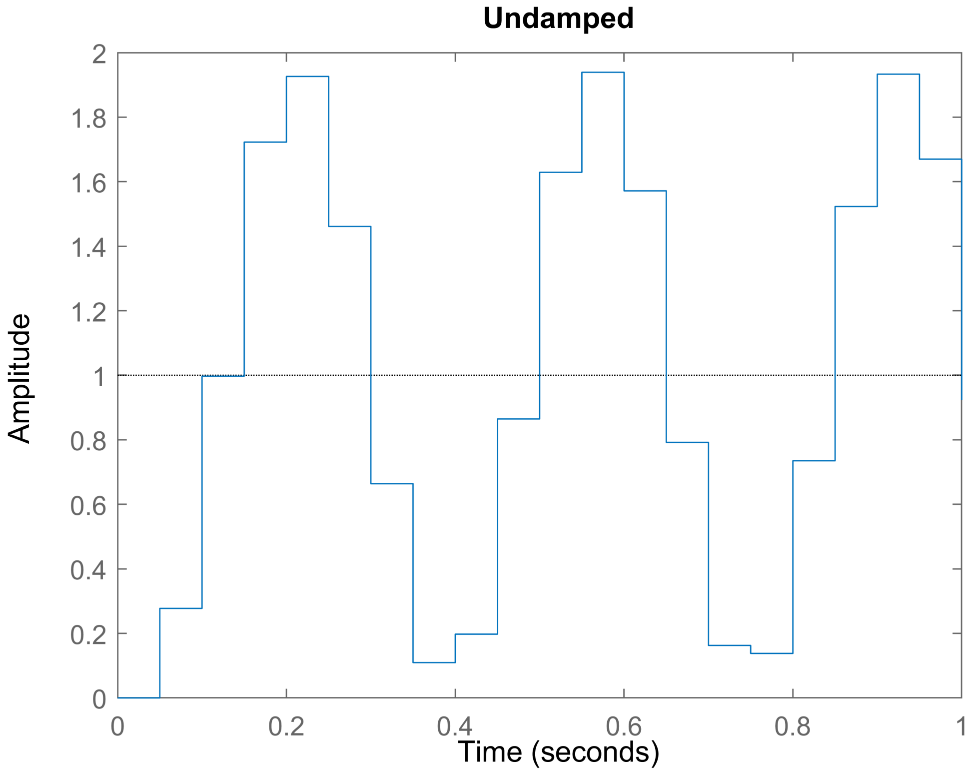
```
figure;
step(feedback(100*H_ol,1),1); title('Unstable system')
```




```
figure;
step(feedback(2.2*H_ol,1),1); title('Underdamped')
```

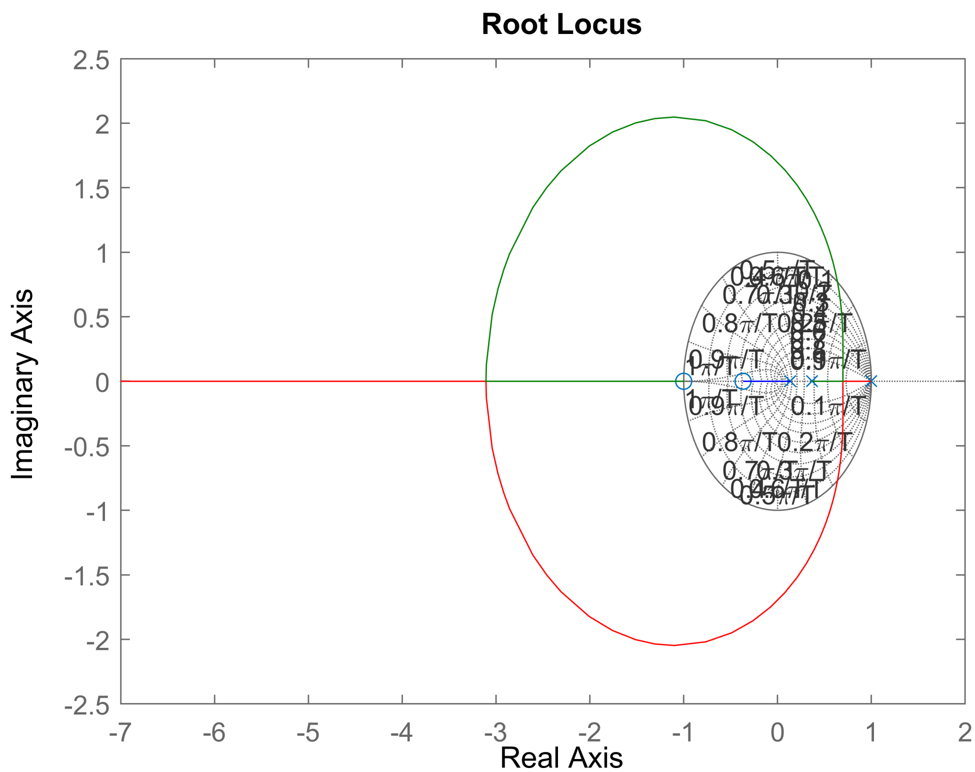


```
figure;
step(feedback(9.26*H_ol,1),1); title('Undamped')
```




### 3.1.6. Use the zgrid functionto obtain the value of k for which the overshoot of the closed loop is below 10%.

```
figure,
rlocus(H_ol)
zgrid
```


Root Locus
Imaginary Axis
Real Axis
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
-7
-6
-5
-4
-3
-2
-1
0
1
2